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Laser Safety Inspection Criteria

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A responsibility of the Laser Safety Officer (LSO) is to perform laser safety audits. The American National Standard Z136.1 Safe Use of Lasers references this requirement in several sections:

1) Section 1.3.2 LSO Specific Responsibilities states under Hazard Evaluation, "The LSO shall be responsible for hazards evaluation of laser work areas",
2) Section 1.3.2.8, Safety Features Audits, "The LSO shall ensure that the safety features of the laser installation facilities and laser equipment are audited periodically to assure proper operation", and
3) Appendix D, under Survey and Inspections, it states, "the LSO will survey by inspection, as considered necessary, all areas where laser equipment is used".

Therefore, for facilities using Class 3B and or Class 4 lasers, audits for laser safety compliance are expected to be conducted. The composition, frequency and rigueur of that inspection /audit rests in the hands of the LSO. A common practice for institutions is to develop laser audit checklists or survey forms. In many institutions, a sole Laser Safety Officer (LSO) or a number of Deputy LSO's perform these audits. For that matter, there are institutions that request users to perform a self-assessment audit.

Many items on the common audit list and the associated findings are subjective because they are based on the experience and interest of the LSO or auditor in particular items on the checklist. Beam block usage is an example; to one set of eyes a particular arrangement might be completely adequate, while to another the installation may be inadequate. In order to provide more consistency, the National Ignition Facility Directorate at Lawrence Livermore National Laboratory (NIF-LLNL) has established criteria for a number of items found on the typical laser safety audit form. These criteria are distributed to laser users, and they serves two broad purposes: first, it gives the user an expectation of what will be reviewed by an auditor, and second, it is an opportunity to explain audit items to the laser user and thus the reasons for some of these items.

The following are some examples from the audit criteria handout. As an explanatory key to the reader, an Operational Safety Procedure (OSP) as a formally reviewed safety procedure required for all Class 3B & Class 4 laser installations. An "OSP Binder" contains all safety documentation related to a given laser operation and serves as a central repository for documents, such as the OSP, interlock logs, lessons learned, contact information etc. "Unattended Operation" refers to approved procedures for unattended operation of the laser installation and may include operation beyond normal working hours. "L-train" is the LLNL training tracking system.

Safety Documentation

Interlock Log: OSP's that require interlock checks (quarterly is the NIF standard frequency), need to be current. Current is 1 check per quarter (no more than 90 days between checks is the goal). These checks are generally an operational performance check. For complex systems a written procedure is required for the tester to follow and note problems. The preference is a written procedure for all labs to follow. This assures consistency between checks regardless of who in the lab performs the check. If problems are noted, follow up action and documentation of resolution is required.

Alignment Procedure: At a minimum, there should be a section in the OSP binder that gives general laser alignment guidance (contact the NIF LSO for a copy). Whenever possible, laser use specific alignment procedures should be developed for the different laser activities. System start up procedures could go in this section.

Training Matrix: In one axis it lists all courses required by the OSP and the other axis list authorized workers for that OSP. Check for compliance with Laser Safety Training (HS5200) and laser eye exam. The matrix needs to be signed twice a year. The new Matrix has a six-month renewal column for initials. Matrix

must include all present authorized laser users. Make sure the list of required courses in the OSP, Section 8 is represented on the Training Matrix form.

Posting & Labeling

Hazard Communication poster: Laser hazards need to be on Hazard Communication poster. Check the poster to see it represents all hazards in the room, not just your work.

Laser sign: Laser use areas with Class 3B or Class 4 lasers are required to be posted with a laser warning sign (supplied by NIF LSO). The sign should accurately convey the wavelengths in use and any laser protective eyewear requirements. The sign needs to be on all accessible entrances to the laser use area.

Unattended Sign: When unattended operation is permitted, this sign needs to be available for use. The contact information must be accurate.

Emergency Contact: Many lab doors have emergency contact information posted. It must be readable and accurate.

Beam Enclosures

The goal is to contain the laser beam and any stray radiation to the optical table or intended use area. Enclosures that confine the beam are one of the best methods to accomplish this. This means individual portions of the laser beam can be contained as in a beam tube, or containment can be of the optical set up, by means of a barrier around the entire table or portions of it. This barrier can be several inches higher than the intended beam path, open or closed at the top, or panels several feet high enclosing the entire table.

Total enclosure This is the preferred but not always possible method. Panels can be labeled with an interlocked or non-interlocked warning label(s). Contact NIF LSO for Lessons learned on design of such enclosures.

Totally open While not preferred, in some cases it maybe the only workable option. In such a case, use of properly placed beam blocks is critical to safety. A check for stray reflections is required after each alignment or beam manipulation.

Combination In some cases beams will not be totally open or totally enclosed but at times a combination of both. A combination approach is acceptable and real.

Perimeter guard It must be of sufficient height above the intended beam height to prevent a likely stray reflection from rising above the guard.

Beam tubes For open distances between optics over 2 feet it is recommend beam tubes be mounted. The tube while preferred need not be of a material opaque to the laser radiation. Keeping hands out of the beam is the major goal.

Open path walkway

At times it may be needed for the laser beam to pass from one optical table to another across an open walkway space. In such cases the level of controls can vary by the hazard presented by such a beam. If the beam is below MPE the user may choose to use administrative means, i.e. signs.

Permanent Beam Tube: This is the preferred control, but may present emergency or traffic control problems.

Removable Method: For the reasons above, a removal tube may be the best solution. In such cases, a control must be in place to prevent the laser radiation from crossing the open space without the tube or awareness of users in the lab. Some approaches have been removable tubes, tubes or bars or swing arms, chains across the area, swing gates.

Protective eyewear

Laser protective eyewear is a critical part of laser safety for the individual. Chiefly, it relies on the user to wear the proper eyewear and take care not to abuse the eyewear. All laser user need to know they have an obligation to make sure all in the laser lab are wearing the proper eyewear when a laser radiation hazard is present.

Full Protection: This type is designed so that the optical density of the eyewear will absorb all the laser radiation from a direct hit for a period of up to 10 seconds. Since intra beam or direct viewing of the laser beam is strictly forbidden.

Alignment: Use of alignment eyewear is allowed for visualization of visible beams for alignment activities. The NIF LSO grants approval of such eyewear.

Labeled: Required labeling is optical density (OD) and wavelengths the eyewear designed to provide protection from. Labeling on some common styles of eyewear can wear off. All eyewear needs to be labeled and readable, otherwise it must be removed. Labeling can be self adhered.

Quantity: The quantity on hand must be sufficient for the expected number of daily users and anticipated visitors. Visitors should be limited to full protection eyewear only.
Condition: Laser eyewear must be in good condition, free from scratches, abrasions, burns, in critical vision areas. The NIF LSO needs to be contacted to determine if the eyewear still provides the level of protection required.
Correct OD: The OD on eyewear must meet the limits set forth in the laser table for the laser application.
Prescription Age: Due to the cost of prescription laser eyewear, the user may be using a pair with a prescription several years old. A consult with Health Services is required to determine if a new set of eyewear is required.
Storage: Eyewear must be stored in a manner that preserves its condition. Storage can be outside the laser use area or inside. Each has advantages and disadvantages
Holder: The storage of laser protective eyewear will have a direct effect on its lifetime. The practice of eyewear being thrown in a draw or left on tables (at the end of the day) is to be considered unacceptable. A wall pouch holder can be obtained from the NIF LSO.

Beam Containment

Beam Blocks: These should be made out of a non-combustible material for the power output expected to strike the block. It must not transmit the wavelength in use. Cardboard maybe suitable for some applications while metal will be required for others. The block should not be reflective for the wavelengths being used. All active beam blocks must be secured to the optical table (unless foot print stops tip over and approved by NIF LSO). The size of the blocks must be sufficient to block the beam diameter and possibly miss-aligned beam. A label on the block indicating that it is a beam block and not to be moved is recommended but not required. Such labeling is considered a good practice to help locate any beam blocks that might be misplaced or knocked over.
Path to door blocked: There should not be a direct path form the laser use area to a door exiting outside the laser use area. Blockage of this path can be through a Curtain, Partition or a barrier on the laser table.

Fiber optics.
Container for Sharps: If the user is cutting and slicing fibers a container is required for sharp ends, following standard sharps protocols.
Fiber ends labeled: Near or where the beam exists the fiber, a label is required to make staff aware of this hazard point (unless alternate controls have been approved)
Conduit labeled: The conduit carrying laser radiation levels above Class 1 need to be labeled at least every 3 meters and at points where they enter or exit a wall.

Housekeeping

On laser work surfaces: The area on the optical table encompassing and directly adjacent to the beam path needs to be free of all non-essential reflective sources. This includes optics, tools, foil, and storage containers. This does not include established alternate beam paths for related experiments.
Related work surfaces - Adequate Storage space: Space is always a premium in any laboratory; the more organized the space is the safer the work area will be. Divisions and programs should make resources available to individual labs to aid in this goal. Users have a dual responsibility here, first to remove unused equipment, either to surplus or storage outside the lab, and most importantly, to keep an on going effort to organize and put away supplies.
Chemical Storage: Chemicals present several hazards to the user as an ignition /combustion source to an irradiant. Their proper storage and use is critical to personnel safety, particularly when laser dyes are in use. In choosing secondary containers, please keep in mind while plastic trays are cheaper and easy to obtain they do not offer the resistance to fire that metal trays do, not give off toxic chemicals when burning.
High storage: Adherence to seismic guidelines needs to be checked on shelves and on the top of racks
Trip hazards: To protect cords and hoses from tears and prevent tripping over the same, a number of commercial devices are available. The application of these devices needs to be reviewed during the audit.
Emergency lighting: The reviewer should see if it is present, working and located in adequate locations.

Associated Hazards

Awareness of non-beam or associated hazards has always been a part of laser safety audits. An effort should be taken to see that they are addressed.
Robotic Safety: Check to see if users received training on this topic.
Electrical Safety: Check to see if AHJ has been applied to the equipment in the laser use area.

Summary

The goal of the above list is to aid the laser user in understanding laser safety which hopefully will lead to compliance of the many items, reviewed during a laser audit, in the hope that through an explanation of these common items, it will help them work safer. At NIF, our Goal is Zero (accidents).

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